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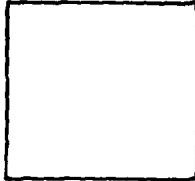
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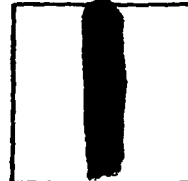
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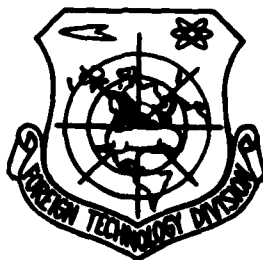
FOREIGN TECHNOLOGY DIVISION



MAN-MADE HEAVENLY PALACE

By

Shu Tien



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MAN-MADE HEAVENLY PALACE

Shu Tien

The words "heavenly palace" carry with them a mythological color. In the movie, "Monkey King Caused Havoc in Heavenly Palace", the majestic palace and the beautiful peach garden was created by the imagination of human beings for thousands of years. However, as space technology advances, the possibility of building a space city which will be even more majestic than the imaginary heavenly palace can no longer be discounted.

In order to make space more beneficial to human beings, mankind hopes to build a man-made heavenly palace which has factories, farms, and life support facilities. Hundred and thousands of people will live in this glass, ship-like flying castle for generations. They will live and work there to produce products which can not be made on the earth, and to cure serious illness, plant high-yield farm products.... This is a high ideal and is also a challenge to nature. The question is: could it be realized?

Since, the sixties, space travel has proved that human beings can work in space for days or even months. Nevertheless, in order for human beings to be able to stay in space for a long duration as they do on the earth, a man-made heavenly palace which has a gravitational field and atmosphere equivalent to that on the earth has to be constructed. It also must have sufficient water, food, and energy sources. To build such a city in space, a large amount of material and equipment transported from the earth and other heavenly bodies are required. The difficulty involved is so great that it has been beyond the imagination of human beings for thousands of years and could not be overcome. But as space technology advances rapidly, gradually solutions appear on the horizon. The topic of "Man-made Heavenly Palace" evolves from

fantasy to a scientific study. A beautiful blue print **unfolds** in front of us.

After a lot of thoughts and discussions which went on for the past decade, proposed studies for the heavenly palace have been presented. The more advanced ones are a wheel-like crystal palace and column twin-cities.

Wheel-like Crystal Palace

The one which perhaps has the highest probability of being realized is a wheel-like crystal palace rotating about a central axis. This kind of man-made heavenly palace can accommodate about ten thousand people. The diameter of the wheel is one thousand seven hundred and ninety meters. Within the one hundred and thirty meter tube, forest, grass land, farms, stores, schools, public facilities, partial factories, and hospitals are distributed. The whole wheel ring is coated on the outside with moon dust to make a radiation protection shield. It can absorb cosmic rays to prevent cosmic rays from exerting bodily harm to human beings. Several tens of meters from the "ground" is the arch glass roof; it scintillates under the sun and is transparent like crystal—hence the name crystal palace.

The wheel-like crystal palace **spins** at a rate of one revolution per minute. The centrifugal force creates an equivalent gravitational field for the people living on the rim of the wheel. The central axial part of the wheel is still in a state of weightlessness. This is ideally suitable for building factories to produce products which can not be made under a gravitational field. The factories in the crystal palace can also produce life support items such as oxygen and water from materials transported from other heavenly bodies. Still many necessities (such as food in the early stage) have to be shipped from earth. The central part of the wheel-like crystal palace can also be used for communication facilities, and "piers" for space ships. The residents of the crystal palace lead a life normally just like that on the earth. They

ride an elevator to go to work in the factories in the weightless part of the palace. At the top of the crystal palace, there is a large inclined **reflector mirror**. Together with a series of reflector **blinds** inside the crystal palace, they enable sun light to shine into **the interior** of the palace, yet reflect the **cosmic** rays.

The wheel-like space city looks like a large green palace. The sun shines into the palace through a crystal-like glass roof. Inside the palace are birds flying in the forest, cars moving on the highways. There are people who take a walk for relaxation. There are also people riding on the elevator to go to work. Everything is lively and full of spirit. Two illustrations inside the cover of this magazine show the constructions inside the palace. Mankind not only can obtain enough life support materials from the palace, **but can** also produce fuel for rocket engines, assemble space solar energy stations, manufacture and launch space sensors. It utilizes the space environment to its fullest extent to explore the universe, to produce more material bases for human beings. From this point of view, it is not only possible but necessary for this imagination to become a reality.

However it is not an easy task! To accomodate ten thousand people, the material for the wheel shell is about fifty thousand tons. In addition to this, we also have radiation protecting shields made from moon dust, factory equipment, soil and rocks, etc. The wheel-like crystal palace will weigh more than one hundred thousand tons. Although ninety-eight percent of these materials can be obtained more economically and conveniently from other heavenly bodies other than the earth, some of them still have to be shipped from the earth. If space technology advances at the present pace, a space shuttle will start its service in 1980. It can ship one thousand and seven hundred tons of material to a space station in a year. An optimistic estimate indicates that it will be 1990 before we can start the building of a crystal palace.

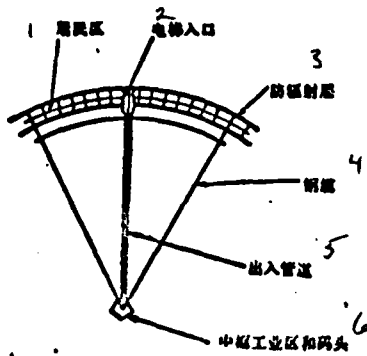


Figure 1. Wheel-like heavenly palace

key: 1 - Residential area; 2 - Elevator entrance; 3 - Radiation protecting layer; 4 - Steel cable; 5 - Tunnel; 6 - Central industrial area and pier

Column Twin-City

Another more advanced design under consideration is a combination of two large columns forming a column twin-city. Every column rotates at a rate of half revolution per minute. This creates an earth-like gravity on the inner wall of the column. Every column is thirty-two kilometers long, and has a diameter of 6.4 kilometers. Inside there are parks, trees, man-made lakes, etc., to make the environment very close to that on the earth. The two columns are separated about ninety kilometers. They can move about between the two columns. Even though

they are very close, their seasons are completely different. When one of them is in summer, the other is in winter just like the northern and southern parts of the earth. The columns are equipped with three long rectangular reflector mirrors. The sun light is reflected through these mirrors to shine into the column. By controlling the orientations of these reflector mirrors, the distinction between night and day, the four seasons are simulated. At the top of the twin-city, there are coffee-cup-like structures which contain the farms. At each end, there is communication equipment and space stations.

These column twin-cities can support between two hundred thousand to twenty million lives. Millions of tons of construction materials are needed. It will not be realized until the twenty-first century. Table I lists four designs for column twin-city.

Aside from the wheel-like crystal palace and column twin-city, there are other designs which are still in the infant stage, such as "spherical man-made heavenly palace" and "Sun Flower City" (see inside cover pictures). The spherical heavenly palace (Figure 2) has a nucleus of a rotating sphere with a diameter of 1.6

TABLE I. FOUR DESIGNS OF COLUMN TWIN-CITY

	1	2	3	4	5
	圆柱体 长度 (公里)	圆柱体 直径 (公里)	自转 周期 (秒)	可住人口 (万)	最早实 现的可 能年份
1	1	0.2	21	1	1988
2	3.2	0.64	36	10~20	1996
3	10	2	63	20~200	2002
4	32	6.4	114	20~2000	2008

Key: 1 - Length of the column (km); 2 - Diameter of the column (km); 3 - Spin period (second); 4 - Possible population (ten thousand); 5 - Possible date of realization

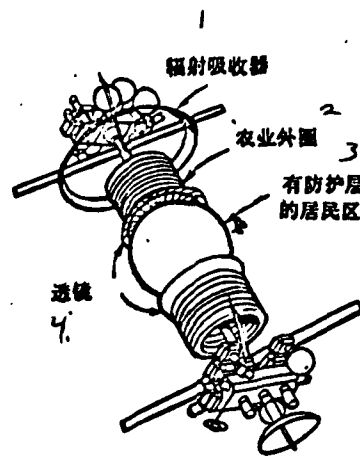


Figure 2.

Key: 1 - Radiation absorbing equipment; 2 - Outer ring for farming; 3 - Residential area under protecting layer; 4 - lens

kilometers. It can accommodate about ten thousand people. At each end of the sphere, there are a solar energy station, space factories and spacecraft stations.

The sun flower city (see inside cover 3) can accommodate about ten thousand people. The reflectors are like petals, always pointing toward the sun to obtain solar energy. The interiors are residential areas. The outer regions are for farming.

The Production and Transportation of Construction Material for the Man-made Heavenly Palace

As discussed before, to construct a man-made heavenly palace, a large quantity of material is needed. To use the simplest column twin-city design in Table I, example 1, more than half a million tons of material is required. This includes aluminum, glass, water, power station equipment, machine tools, soil, rocks, and food. (See Table II).

As we all know, to transport such an amount of material from earth to space is very costly. Therefore, whether one can obtain a large portion of it from other planets (such as the moon, other planets, etc.) is the key to the successful realization of a

TABLE II. MATERIALS NEEDED FOR DESIGN 1 OF TWIN-CITY

Material	Quantity needed (ton)	Originate from the earth (ton)
Aluminum (structure)	20000	0
Glass (reflect solar rays)	10000	0
Water	50000	0
Power station equipment	1000	1000
Special equipment and machine tools	1800	1800
Soil, Rock, etc.	420000	0
Liquid hydrogen	5400	5400
Construction workers and facilities (2000 workers)	200	200
Food	600	600
Total	> 500000	10000

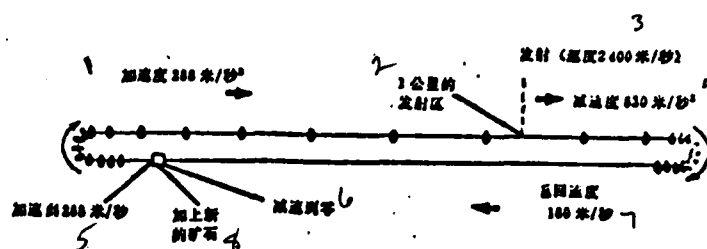


Figure 3. Schematic diagram of the principle of magnetic launch belt on the moon's surface.

Key: 1 - Acceleration 288 m/sec²; 2 - 1 km launch belt; 3 - Launch (velocity 2400 m/sec); 4 - Deceleration 830 m/sec²; 5 - Accelerated to 288 m/sec; 6 - Reduce to zero; 7 - Return velocity 180 m/sec; 8 - Add new mineral rocks

man-made heavenly palace. From past missions to the moon, a lot of moon rocks were brought back. After an analysis, it was determined that the moon rocks are rich in aluminum, titanium and silicon. It can fulfill the need of constructing a man-made heavenly palace. Since the gravitational field on the moon is much weaker, the escaping velocity for the space vehicles which transport this material is smaller. This reduces the cost of transportation significantly. Therefore if one chooses the moon as our base and ship the moon rocks to space for processing, ninety-eight percent of the material can be obtained from the moon.

According to estimates, one hundred and fifty mine workers can produce about one hundred thousand tons of moon rocks in a month. They can use the space shuttle's extra fuel tank as a mobile home. Each tank can accommodate about ten to fifteen people. A large quantity of the material can be gathered within a few months. If a long period of living is planned, then a residential area has to be established. Presently no such necessities exist.

In order to send the moon rocks from the moon to the collection station, we need a transportation scheme which is highly efficient. The present design uses a magnetic floating scheme for acceleration -- the so-called magnetic launch belt.

The launch belt is about twenty-nine kilometers long formed by seventy-five to three hundred magnetic floating devices. Every magnetic floating device weighs about five kilograms and can carry nine kilograms of moon rocks. It accelerates under an electromagnetic force and reaches an escape velocity. At that time, it releases the rocks which travel at a speed of 2.4 kilometer per second to a pre-determined location of the rock collection station. After releasing the rocks, the magnetic floating device decelerates under the force of a magnetic coil and returns to a stationary point. It loads the rock in 0.6 seconds, and accelerates again. (see Figure 3). The set-ups also have several different designs. The number and energy source are all different in these different designs. The ideal case is where one can launch six hundred thousand tons of rocks from each magnetic belt each year.

One can dig a hole two hundred meters wide, two hundred meters long, and five meters deep on the moon's surface. The material contained in the hole will be enough building material for constructing a man-made heavenly palace for ten thousand people. Inside cover 3 is a picture showing the digging of rocks on the moon, and three different sets of magnetic launch belts. Figure 4 is the schematic diagram of constructing the man-made heavenly palace.

So far we have discussed only the construction material, its source, and transportation problems. Aside from these, there are other problems related to the man-made heavenly palace. For example, how to process the rocks in space, how to do construction work in space, how to insure radiation protection at the construction site and how to secure the energy source and logistics, etc. Even if the palace can be constructed, there will be problems related

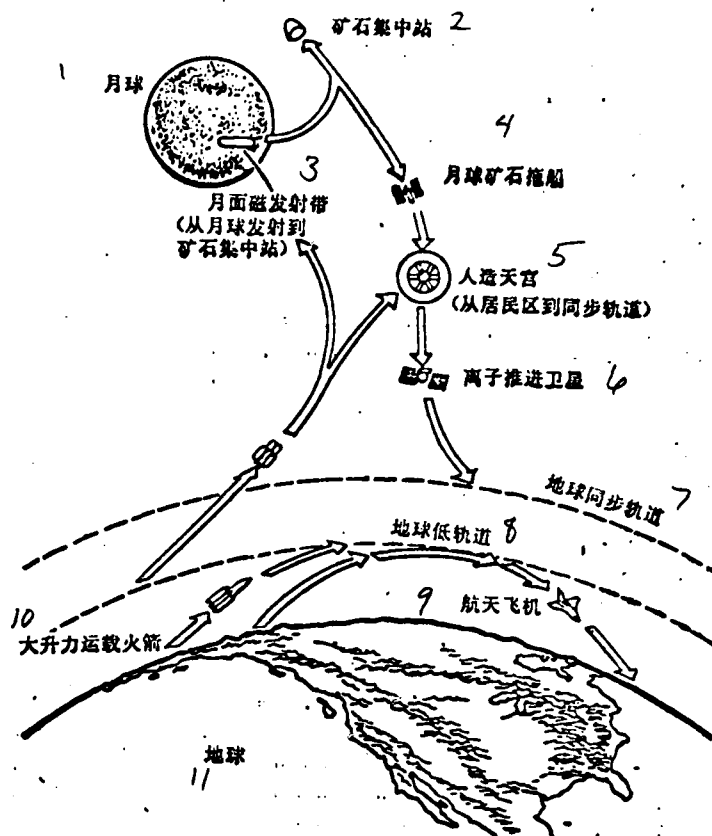


Figure 4. Schematic diagram of constructing man-made heavenly palace

Key: 1 - Moon; 2 - Rock collection station; 3 - Magnetic launching belt on the moon surface (to launch from the moon to rock collection station); 4 - Moon rock carrier; 5 - Man-made heavenly palace (from residential area to synchronized orbit); 6 - ion propulsion satellite; 7 - Earth synchronized orbit; 8 - Earth lower orbit; 9 - Space shuttle; 10 - Large thrust carrier rockets; 11 - Earth

to physiology, sociology and others which have not yet been determined. In the design stage, a lot of difficulties have been uncovered. With the advance of technology, the probability of its realization is increasing.

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